(12) UK Patent Application (19) GB (11) 2 255 941 (13) A

(43) Date of A publication 25.11.1992

(21) Application No 9210125.2

(22) Date of filing 11.05.1992

(30) Priority data
(31) 9111285 (32) 24.05.1991 (33) GB

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(51) INT CL[5]
B62D 12/00

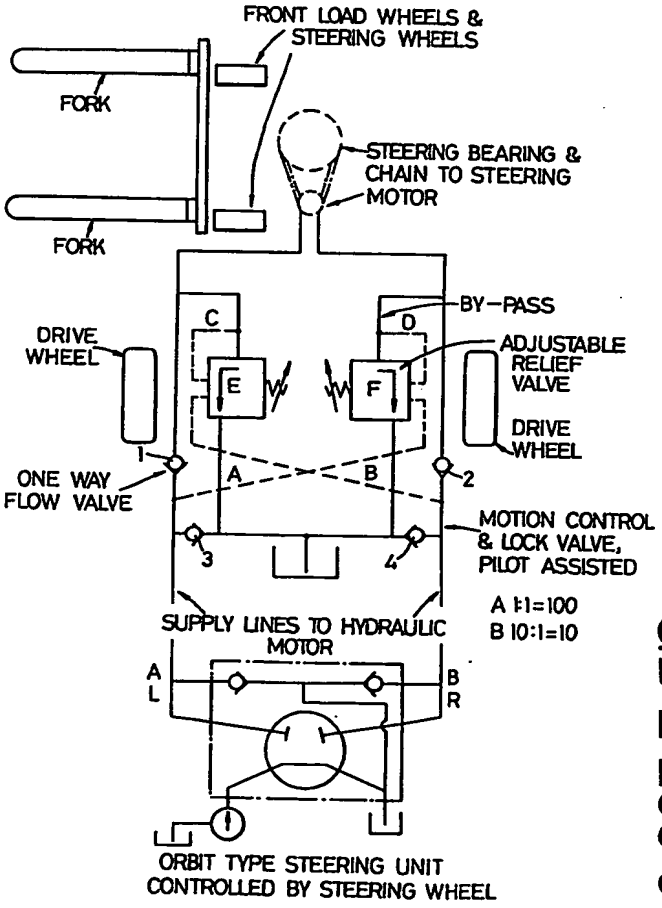
(52) UK CL (Edition K)
B7H HFJ H852 H853 H872

(56) Documents cited
EP 0303413 A1 US 4310062 A

(58) Field of search
UK CL (Edition K) B7H HA HFJ
INT CL[5] B62D 12/00

(54) Narrow aisle lift truck steering system

(57) A narrow aisle lift truck has hydraulic control of steering with means to prevent oversteer by reaction between the wheels and the ground. When steering left, hydraulic fluid flows via line A to the motor and exhausts from the motor through the opposite line B and via a relief valve F which is opened by the pressure in line A. When the steering angle remains constant there is no pressure in A and valve F is closed so that any forces tending to deflect the steering either way are resisted by the one-way flow valves in line A and the closed relief valve F. Bypass C, D are arranged to open under excess pressure so that in the event of for example accidental impact raising the pressure in one or other line the appropriate relief valve opens and this guards against damage to the circuit.



GB 2 255 941

NARROW AISLE LIFT TRUCK

This invention relates to narrow aisle lift trucks which are intended for use in industrial warehouses and the like. In these warehouses the loads, often palleted. are inserted at right angles to the face of the stack in spaces in the honeycomb cell-like arrangement of the faces of the storage racks, and extracted in like manner. To minimise space utilization, the aisle is to be kept relatively narrow.

One proposal for a truck for use in these narrow aisles has the truck in two parts with a central pivot. There are four wheels in the usual two parallel-axle relationship. The front part of the truck carries the mast, forks and load, and the rear part carries the driver, propulsion motor and counterweight to balance the load. Loads and counterweights of one or two tonnes are commonplace. Steering is effected by turning the front part as a whole about the pivot axis. Typically chain drive is used from a steering motor on the rear part. In such a truck it is possible for the front part to be at 90 degrees or even more to the rear part. If both rear wheels are driven, the rear part always attempts to travel in a straight line normal to the axis of the rear wheels, but when the front wheels are at 90 degrees they are in the worst possible position since their axis is parallel to the attempted direction of movement of the rear part of the truck. So the wheels skid sideways with a high rate of tyre wear. At less extreme angles of the two parts, the tyres may grip the road, but the forces applied may tend to displace the steered wheels in the steered direction ("oversteer") and this applies forces to the steering mechanism.

The value of the feedback forces depend upon the steered angle and are most severe in the manoeuvreing necessary for load insertion and extraction. Experimental usage of a truck according to the above proposal has shown that without special measures it is

possible for the feedback forces to take over the steering and this may slam the front part onto full steered lock, which could overbalance the truck or cause damage for example broken steering chains, and at the very least cause the driver severe fatigue in attempting to resist them.

It is believed that these difficulties have hitherto prevented widespread use or development of this basic design. Instead, designers have explored the several separate possibilities of either steering the wheels individually, including four wheel steering, or tank steering, or using outrigger wheels to prevent overbalancing, or driving the rear wheels in opposite directions or speed and load limiters, and often some combination of these ideas all of which have increased costs and reduced work capability.

According to the invention, a narrow aisle lift truck of the kind comprising a truck body mounted on a pair of driven wheels, a mast structure carrying lift forks mounted on a pair of non-driven front wheels, a centre pivot between the body and mast, and steering means for varying the angle of the body to the mast, is characterised in that steering forces are transmitted from a driver's steering control to the steered part via a one way transmission device which prevents oversteer and feedback forces applied to the steering mechanism.

One present preferred embodiment of the invention is now more particularly described with reference to the accompanying diagrammatic drawing which shows the steering and truck elements in a position with the front wheels turned through 90 degrees relative to the rear wheels. Steering is via a steering unit supplying oil to a hydraulic motor. The motor provides the necessary torque to steer the truck, i.e. cause movement about the centre pivot, and relays it via a chain transmission with gear reduction.

When the operator steers the truck to turn either to the left. or right. oil passes out of either the L port

to steer left or R port to steer right.

To steer left: oil passes out of port L via line A through the one-way flow (check) valve 1 into the hydraulic motor, out of the motor through the pilot operated relief valve F, through one-way check valve 4 and back to tank through the steering unit. Because of the hydraulic pressure in the line between the valve 1 and the motor, the communicated pressure via the branch line A pilots (opens) the relief valve F for this purpose. There are two pilot inputs to relief valve F, namely A and D: there is a ratio between the pressures required to open the relief valve via the different sources. If the ratio is 10:1 it requires ten times the pressure in port D to open it than in port A. A ratio of about 10 to 1 is preferred. If there is no pressure in lines L or R the steering angle is held constant by check valves 1 and 2 and relief valves E and F in the closed positions.

To steer right: turns to the right are achieved by oil leaving the steering unit at port R via line B and following the opposite path to that in a left turn, i.e. via one-way valve 2, and pilot operation of relief valve E via branch B.

Run on: if feed back of forces attempts to change the steered angle (oversteer) by the force induced from the truck driving forward, pressure will fall in the appropriate supply line via the valve 1 or 2 from port L or R and corresponding pilot valve F or E then closes. This closure prevents exhaust of fluid from the motor back to tank so as to hold the motor and hence the steering in the set position.

Certain other events such as accidental impact between the steered part and an obstacle or the driver sensing oversteer, and attempting to correct by steering in the opposite direction can also apply excess loads to the hydraulic system by reaction of the motor against the hydraulic fluid. The forces acting on the parts may drive the steered part in the opposite direction to that

of the steering force. For example if the steering force is turning the truck to the left the line via port L and valve 1 is pressurised. An impact in the same direction will cause a pressure surge in that line which could damage the motor, result in burst hoses or fittings, or damage the chain and gears.

According to an important feature of the invention this damage is avoided by the bypass system. Thus assuming the pressure surge exceeds that needful to operate the relief valve by way of the bypass, the corresponding relief valve opens to exhaust fluid in that line. For example, when steering left, valve F is opened by line A, but valve E is opened by the bypass C when the pressure in the left steer line exceeds the normal operating pressure by the mentioned ratio. The use of a ratio such as 10:1 ensures that normal variations in hydraulic pressure do not cause undesired relief operation. The 10 to 1 or other ratio may be achieved by balancing pressure applied to pistons of different area in control valves or by adjustable check valves for example.

It will be understood that pressure surges in the righthand line are dealt with in the same way as in the lefthand line, but in this case by bypass D. One-way valves 3, 4 allow exhaust flow.

The one-way valves, relief valves and connections may all be provided in a single unit, called a motion control valve.

An alternative steering system (not shown) uses a pair of hydraulic rams extending between the pivoted parts. Hitherto these have, or may have been, single acting, in that in order to steer the truck fluid has been supplied to one end of one ram and the other ram has been open to exhaust. The undesired feedback forces or other oversteer forces effectively extend the pressurized ram in the same direction as the pressurized fluid, and there may be only light spring face provided in that ram to resist this. The invention may be applied to this

arrangement in generally the same way as described for the steering motor, in which case exhaust of fluid from the opposite ram would be prevented or controlled thus providing a resistance to the oversteer movement. Alternatively, double acting rams can be used in which fluid flow to one end of one ram is via the pump for steering, flow from the opposite end of the same ram is via a motion control valve to prevent undesired rapid movement of the steering and likewise the ram, and with recirculation of fluid from one end to the other of the second ram via a further restrictor or motion control valve as a further check against undesired steering movements.

However the invention can also be applied with non-hydraulic means. For example using a pair of oppositely directed free wheel devices on the main pivot with disc brakes or like friction means to act as the transmission clutch between one or other of the steered parts. In such an arrangement, a positive movement of the steering wheel by the driver will declutch the free wheel which prevents movement in the desired direction only during the time when the steering wheel or tiller is actively moved. At other times the steering will be held in the set position but is capable of movement against the resistance of the disc brakes so as to give the desirable "feel" to the steering.

CLAIMS

1. A narrow aisle lift truck of the kind comprising a truck body mounted on a pair of driven wheels, a mast structure carrying lift forks mounted on a pair of non-driven front wheels, a centre pivot between the body and mast, and steering means for varying the angle of the body to the mast, is characterised in that steering forces are transmitted from a driver steering control to the steered part via a one way transmission device which prevents oversteer and feedback forces applied to the steering mechanism.

2. A truck as claimed in Claim 1 wherein the steering comprises a hydraulic motor fed directionally with hydraulic fluid from a steering control, including a one-way valve in each of two lines corresponding to the two directions of movement of the said motor, and a relief valve effective in each line, each valve being opened by pressure in the opposite line whereby fluid is supplied by one line and exhaust return flow to the motor permitted via the relief valve in the other line.

3. A truck as claimed in Claim 2 wherein each said relief valve is also arranged to be opened by excess pressure in the corresponding line.

4. A truck as claimed in Claim 3 wherein the valve is arranged so that it opens normally via normal operating pressure in the opposite line or under excess pressure of substantially higher value in the corresponding line.

5. A truck as claimed in Claim 1 wherein the steering comprises a pair of hydraulic rams arranged in hydraulic circuit so that one end of one ram is pressurized to steer in one direction and one end of the other ram is exhausted for the same purpose, and vice versa for the opposite direction of steering, in which the circuit includes a motion control valve having relief valves effective in each line and opened by pressure in the opposite line to allow exhaust in said line and arranged so that if said pressure falls when oversteer is caused

by excess forces the open relief valve will close to prevent said exhaust and control the oversteer.

6. A truck as claimed in Claim 5 wherein the relief valves are also arranged to be operated by excess pressure in the said lines to vent excess pressure therein.

7. A truck substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9210125.2

Relevant Technical fields

(i) UK Cl (Edition K) B7H (HA, HFJ)

(ii) Int Cl (Edition 5) B62D 12/00

Search Examiner

J L TWIN

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

17 JULY 1992

Documents considered relevant following a search in respect of claims 1

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	EP 0303413 A1 (TRANSLIFT MATERIAL HANDLING)	1
Y	US 4310062 (LINK ET AL) - (see eg Column 5, lines 22-42)	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

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